

What is claimed is:

1. A method of detecting fade in an area of each of
a sequence of frames comprising pixels that represent
5 digital video images, comprising the steps of:

calculating a stochastic measure σ_d of said area based
on the standard deviation of differences in pixel values in
at least two of said frames; and

detecting fade in said area by comparing the
10 stochastic measure σ_d with a given noise level, such that if
the difference between σ_d and noise level is greater than a
threshold value then fade is detected.

2. The method of claim 1 wherein the steps of
15 calculating the stochastic measurement σ_d further includes
the steps of:

(a) for each logo pixel in the current frame:

(i) determining the difference between the value
of the current pixel and that of a corresponding pixel in a
20 reference frame,

(ii) subtracting the given noise mean from the
said difference and squaring the obtained value; and

(iii) generating a sum of the squared differences with noise mean subtracted for each of a plurality of pixels within the logo area;

(b) generating an average of the sums, and
 5 determining the stochastic measure σ_d based on said average.

3. The method of claim 2, in step (a) generating said sum of the stochastic measure σ_d is according to the
 10 relation:

$$\begin{aligned}\sigma_d^2(i) &= \sum_{j=1}^i \left\{ |d'(j)|^2 \mid f(j) = 1 \right\} \\ &= \sum_{j=1}^i \left\{ |d(j) - \mu_s|^2 \mid f(j) = 1 \right\}\end{aligned}$$

such that:

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$$d(j) = p_c(j) - p_r(j)$$

wherein:

i is the number of pixels that have been examined in the current frame,

20 $p_c(j)$ denotes the pixel value in a current video frame,

$p_r(j)$ denotes the corresponding pixel
intensity value in the reference frame,

$d(j)$ denotes the difference between the
value of the current pixel and that of a corresponding
5 pixel in the reference frame,

$f(j)=1$ denotes the pixel is a logo pixel,
and

μ_s denotes the mean of the noise signal.

10 4. The method of claim 3, wherein determining the
stochastic measure σ_d is according to the relations:

$$\sigma_d = \sqrt{\sigma_d^2}, \text{ and}$$

$$\begin{aligned} \sigma_d^2 &= \frac{1}{M} \sum_{j=1}^N \left\{ |d'(j)|^2 \mid f(j)=1 \right\} \\ &= \frac{1}{M} \sum_{j=1}^N \left\{ |d(j) - \mu_s|^2 \mid f(j)=1 \right\} \end{aligned}$$

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wherein:

M denotes the total number of pixels in said
logo area, and

N denotes the total number of pixels in the
20 current frame.

5. The method of claim 2 wherein:

said area includes a sub-image;

the method further includes the steps of

initially detecting the area including the sub-image, and

5 generating a map including a pixel pattern corresponding

to the video frame, wherein each pixel in the pattern

indicates whether the corresponding pixel in the video

frame is in the sub-image.

10 6. The method of claim 5, further including the
steps of:

using the map to select pixels of the video frame
that are in the sub-image for:

determining the difference between the value
15 of the current pixel and that of a corresponding pixel in a
reference frame, subtracting the noise mean from the
difference and squaring the obtained value; and

generating a sum of the squared values for
each of a plurality of pixels within the said logo area.

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7. The method of claim 1, wherein the noise level is
selected by determining a standard deviation of noise
samples $s(i)$ from the video signal, wherein i is the index
of a digital noise sample.

8. The method of claim 7, wherein the standard deviation of noise, σ_s , within said area can be expressed as:

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$$\sigma_s = \sqrt{\frac{\sum_{i=1}^M |s(i) - \mu_s|^2}{M}}, \text{ when } M \rightarrow \infty.$$

wherein a natural video noise signal is modeled by a random process with mean:

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$$\mu_s = \frac{\sum_{i=1}^M s(i)}{M}, \text{ when } M \rightarrow \infty$$

wherein M is the total number of noise samples.

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9. A method of detecting fade of a logo in a sequence of frames comprising pixels that represent digital video images, comprising the steps of:

(a) for each logo pixel in the current frame:

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(i) determining the difference between the value of the current pixel and that of a corresponding pixel in a reference frame;

(ii) subtracting the given noise mean from the
said difference and squaring the obtained value; and
(iii) generating a sum of the squared differences
with noise mean subtracted for each of a plurality of
5 pixels within the logo area;
(b) generating an average of the sums;
(c) comparing said average to a given noise level
represented by STD, such that if the difference between the
average and the noise STD is greater than the threshold
10 value then fade is detected.

10. The method of claim 2, further including the
initial steps of:

detecting the logo in the video frame, and
15 generating a map including a pixel pattern corresponding
to the video frame, wherein each pixel in the pattern
indicates whether the corresponding pixel in the video
frame is in the logo.

20 11. The method of claim 10, further comprising the
steps of:

using the map to select pixels of the video frame
that are in the logo for:

determining the difference between the value of the current pixel and that of a corresponding pixel in a reference frame;

subtracting the noise mean from said difference,
5 and squaring the obtained value; and

generating a sum of said squared values for each of a plurality of pixels within the logo area.

12. The method of claim 9, wherein the noise level is
10 selected by determining a standard deviation of noise samples from the video signal.

13. The method of claim 12, wherein the noise level is selected by determining a standard deviation of noise
15 samples within the logo area.

14. A fade detection system for detecting fade in a logo in each of a sequence of frames, comprising:

a detector for detecting the logo in a video
20 frame;

a logo map generator generating a map including a pixel pattern corresponding to the video frame, wherein each pixel in the pattern indicates whether the corresponding pixel in the video frame is in the logo;

a logo tracker that detects logo fade by:

using the map to select pixels of the video frame that are in the logo to, determine the difference between the value of the current pixel and that of a corresponding pixel in a reference frame, subtracting the given noise mean from the said difference and squaring the obtained value, and generate a sum of the squared values for each of a plurality of pixels within the logo area;

generating an average of the sums; and

comparing said average to a given noise level, such that if the difference between the said average and the noise level (STD) is greater than the threshold value then fade is detected.

15. The system of claim 14, wherein the noise level is selected by determining a standard deviation of noise samples from the video signal.

16. The system of claim 15, wherein the noise level is selected by determining a standard deviation of noise samples from the logo pixels.

17. A fade detection system for detecting fade in a logo in each of a sequence of frames, comprising:

a detector for detecting the logo in a video
signal;

a logo tracker that calculates a stochastic
measure σ_d of said logo based on the standard deviation of
5 differences in pixel values in at least two of said frames,
and detects fade in said logo by comparing the measure σ_d
with a given noise level (STD), such that if the difference
between σ_d and the noise level (STD) is greater than the
threshold value then fade is detected.

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18. The system of claim 17 wherein the tracker
calculates the stochastic measurement σ_d by:

(a) for each pixel in the logo area of the current
frame:

15 (i) determining the difference between the value
of the current pixel and that of a corresponding pixel in a
reference frame;

(ii) subtracting the noise mean from the said
difference, and squaring the obtained value; and

20 (ii) generating a sum of the squared values for
each of a plurality of pixels in the logo area;

(b) generating an average of the sums, and
determining the stochastic measure σ_d based on said
average.

5 19. The system of claim 18, wherein the tracker
generates said sum of the squared differences, with noise
mean subtracted, according to the relation:

$$\begin{aligned}\sigma_d^2(i) &= \sum_{j=1}^i \left\{ |d'(j)|^2 \mid f(j)=1 \right\} \\ &= \sum_{j=1}^i \left\{ |d(j) - \mu_s|^2 \mid f(j)=1 \right\}\end{aligned}$$

10 such that:

$$d(j) = p_c(j) - p_r(j)$$

wherein:

15 $p_c(j)$ denotes the pixel value in a current
video frame,

$p_r(j)$ denotes the corresponding pixel
intensity value in the reference frame,

$d(j)$ denotes the absolute difference between
the value of the current pixel and that of a
20 corresponding pixel in the reference frame,

$f(j)=1$ denotes that the pixel is a logo pixel, and

μ_s denotes the mean of the noise signal.

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20. The system of claim 19, wherein the tracker determines the stochastic measure σ_d according to the relations:

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$$\sigma_d = \sqrt{\sigma_d^2}, \text{ and}$$

$$\begin{aligned} \sigma_d^2 &= \frac{1}{M} \sum_{j=1}^N \left\{ |d'(j)|^2 \mid f(j)=1 \right\} \\ &= \frac{1}{M} \sum_{j=1}^N \left\{ |d(j) - \mu_s|^2 \mid f(j)=1 \right\} \end{aligned}$$

wherein:

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M denotes the total number of logo pixels in said area, and

N denotes the total number of pixels in the current frame.

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21. The system of claim 18, further comprising a logo map generator that generates a map including a pixel pattern corresponding to the video frame, wherein each

pixel in the pattern indicates whether the corresponding pixel in the video frame is in the logo.

22. The system of claim 21, wherein the tracker uses
 5 the logo map to select pixels of the video frame that are in the sub-image for:

determining the difference between the value of the current pixel and that of a corresponding pixel in a reference frame, subtracting the noise mean from the said
 10 difference and squaring the obtained value; and

generating a sum of the squared values for each of a plurality of pixels within the logo area.

23. The system of claim 17, wherein the noise level
 15 is selected by determining a standard deviation of noise samples $s(i)$ from the video signal.

24. The system of claim 23, wherein the standard deviation of noise, σ_s , within said area can be expressed
 20 as:

$$\sigma_s = \sqrt{\frac{\sum_{i=1}^M |s(i) - \mu_s|^2}{M}}, \text{ when } M \rightarrow \infty.$$

wherein a natural video noise signal is modeled by a random process with mean:

$$\mu_s = \frac{\sum_{i=1}^M s(i)}{M}, \text{ when } M \rightarrow \infty$$

wherein M is the total number of noise samples.